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WAYS OF ENERGY SAVING IN AGRICULTURAL BUILDINGS AND STRUCTURES BLOCKS

The energy saving and efficient resources using problem is important for agriculture in Ukraine. The energy-saving ways, efficient and reusable resources management at agricultural enterprises by means of combining various industrial buildings and structures are analyzed in this article. By using the common air exchange between various purposes production facilities, there is a possibility of vent waste using, which is normally emitted into the environment. Considerable carbon dioxide concentration and moisture excess in the air of livestock or rabbit buildings can be directed into indoor structure to feed plants and humidify the air according to legal requirements. Warm air from the indoor structure can be used for livestock buildings heating costs saving. The studies presented in the article proved that to reduce energy consumption and to use waste products at farms it is reasonable to combine buildings and structures.

Keywords: building, indoor structure, energy efficiency, waste

INTRODUCTION

According to the theoretical calculations of reducing the resource costs on farms, it can be achieved by the mutual exchange of air between the indoor structure and the livestock (rabbit) building. The problem is the correct choice of enterprises to maximize the waste usage and energy saving. We will explore the microclimate parameters requirements for agricultural enterprise areas and ways of waste using.

1. THE AIM OF THE ARTICLE

We must explore ways of saving resources and waste using in agricultural buildings and estimate the efficiency of their implementation at the operating company.

2. THE MAIN MATERIAL

According to the modern technology of productivity rising in the indoor structures, air environment is enriched by carbon dioxide. The known ways to solve this problem have their advantages and disadvantages. To eliminate them, it is reasonable to create systems based on the efficient combining of livestock (rabbits) buildings and indoor structures.

The system of combined livestock (rabbits) buildings and indoor structures, which combines different production environment, should provide the most favorable conditions for efficient production. Alongside with the technological conditions, microclimate affects the manufacturing processes performance. To develop possible variants of livestock (rabbits) buildings and indoor structures combinations, the microclimate parameters in buildings and structures in the real settings were studied, and their effect on the formation of space-planning designs of the complex was determined.

The livestock (rabbits) buildings microclimate is largely formed due to the discharge of heat, water vapor and carbon dioxide by animals in the course of their life activity. Table 1 shows the quantitative values of animal heat and carbon dioxide discharge according to the current standards of technological Ukraine AIC objects designing NSS (National State Standard).

Table 1. **Animal heat, water vapor and carbon dioxide waste indicators**

Animal type		Animal weight [kg]	Heat [W]		Water vapour [g/hour]	Carbon dioxide [l/hour]	
			total	sensible		total	per 1 kg
Cows, nonmilking		400	607	437	250	79	0.20
Calves, aging up to 6 months		50	112	80.7	46.2	12	0.24
		100	230	166	94.7	38	0.38
		200	343	247	141	57	0.29
Replacement growing calves		140	311	224	128	35	0.25
		350	556	400	229	70	0.20
Feeding growing calves		160	454	327	187	50	0.31
		500	927	667	381	120	0.24
		100	1038.3	745.3	116	37	0.37
Lambs, goatlings		30	510.8	368.4	57	18	0.60
Fattening pigs		100	368	266	152	45	0.48
		300	628	452	259	82	0.27
Rabbits	Bucks	4	17.95	12.93	2.05	0.64	0.16
	Does	3.5	22.27	16.03	2.54	0.8	0.29
	Baby rabbits	2	24.68	17.77	2.89	0.89	0.45

Emission standards are given for the air temperature 10°C.

Analyzing the data of carbon dioxide animal emissions, cattle or lambs and rabbit farms have the greatest potential for combining livestock buildings and indoor structures. In livestock buildings, there is the largest emission of carbon dioxide and water vapor per 1 animal, in rabbit and lamb buildings the largest emission is calculated per 1 kg of the animal weight.

On the basis of field studies, it can be concluded that the efficiency of livestock buildings and indoor structures blocking in the single complex can be achieved through the following processes:

– carbon dioxide flowing to a greenhouse from livestock (rabbits) buildings,
– excess oxygen air transportation to the livestock (rabbits) buildings,
– low moisture compensation in the greenhouse with the excess moisture air from the livestock (rabbits) building,
– the incoming air heating in the livestock (rabbits) buildings ventilation system with warm air from indoor structures.

Taking into account efficient use of the waste products of the combined indoor structures and livestock (rabbits) buildings, the technique is developed, permitting to calculate the economic effect of the complex operation.

The economic effect of the combined indoor structures and livestock (rabbits) buildings implementation is achieved due to increasing crop yields and livestock productivity. The problem of calculating this effect within the enterprise can be solved by methods of economic analysis. The main economic indicators of the company's efficiency are its earnings and the production expenses.

To calculate the profit we used the formulas [5]:

$$P = C - S$$
$$P = (C - S)V \quad (1)$$

where:
P - profit;
C - price;
S - self-cost;
V - production valium, for the whole period of the production.

Since investing capital funds to the combined livestock (rabbits) buildings and indoor structures provides the profit growth due to improving production technology and product quality compared the separate structures, the calculations are not made for the whole of the profit, but only for its growth (ΔP), which is calculated as the difference between the profit after the investment ($P2$) and the profit before the investment ($P1$) into the complex:

$$\Delta P = P2 - P1 \quad (2)$$

Meanwhile, it is important to make a profit, because the later the profit is gained, the less time it will be used in economic exchange and bring benefit. Therefore, early profit is more valuable. Therefore, the calculated profit value is adjusted as to the time factor by means of discounting.

According to the State Statistics Service data in 2013 it was produced 3120.9 and 11,377.6 tons of meat live weight and milk, respectively. Livestock in 2013 in Ukraine made: cattle - 4645.9 thousand heads; including cows - 2554.3 thousand heads; sheeps and goats - 1738.2 thousand heads. Average prices of agricultural products in 2013 made: vegetables under glass - 8962.0 UAH/t; cattle (live weight) - 12,901.3 UAH/t; milk - 3364.0 UAH/t (prices are given without VAT, allowances, transport and storage costs). This information shows the topicality and economic viability of combined livestock buildings and indoor structures.

We will define profit increase (ΔP) obtained due to application of the offered combination in view of yield per hectare of greenhouse soil (V) for a year, taking into account the priority of crops [5]:

$$\begin{aligned} P1 &= (C - S1)V1 \\ P2 &= (C - S2)V2 \\ \Delta P &= (C - S2)V2 - (C - S1)V1 \end{aligned} \quad (3)$$

According to the experimental data at feeding plants in indoor structures terms of crop production ripening is reduced by 5÷10% and productivity increases by 10÷15%. Let us calculate the value of growing profit according to formula (3):

$$\Delta P = \left(C - \left(S1 \cdot 0.95 + \Delta S/V1\right)V1 \cdot 1.1\right) - \left(C - S1\right)V1 \quad (4)$$

when:
$S1$ and $S2$ - unit self cost before and after implementation of the combined livestock buildings and indoor structures;
ΔS - additional expenses on operation of the combined livestock buildings and indoor structures systems;
$V1$ and $V2$ - yields before and after implementation of the combined livestock buildings and indoor structures.

To calculate the profit rates per one hectare of combined livestock buildings and indoor structures for one season, we use the statistic data:

$$\begin{aligned} \Delta P &= \left(8962 - \left(8065.8 \cdot 0.95 + \Delta S/280\right)280 \cdot 1.1\right) - \left(8962 - 8065.8\right)280 = \\ &= 66806.92 \text{ [grn/hec]} \end{aligned} \quad (5)$$

The profit growth per one hectare of greenhouse structures for a season is defined at a rate of 66 thousand UAH.

According to the statistic data, one can also calculate the potential of the indoor structures carbon dioxide feeding method Spot by means of animals - N_i, discharging it - a_i - during the daylight hours in the cold season - T. The calculation for the conditions of 100 cows kept indoors and producing 120 liters of carbon dioxide per hour:

$$S_{nom} = \Sigma(N_i \cdot a_i) \cdot T = 100 \cdot 120 \cdot 182 \cdot 9.75 = 21000000 \text{ [L } CO_2\text{/year]} \quad (6)$$

With the market value of liquid carbonic acid in cylinders at 3 UAH/L, according to process design standards in terms of liquefied carbon dioxide in the air obtained from animals, the factor of 1/500 is used; the potential of this feeding method reaches up to 42 thousand UAH a year from a barn, where 100 heads of cows are kept.

Experimental studies also testify to the possibility of cost savings for heating livestock buildings by warm air from indoor structures.

According to NST V.2.5-67 and ISO-LB-27 B.1.1, calculation of energy savings for heating the livestock building by heated air from the indoor structure is presented by the formulas:

$$Q^{an} = \rho_{air} \cdot G_{air} \cdot c \cdot \left(t_{air} - t_{out}\right) \text{ [J]}$$
$$Q^{an} = \rho_{air} \cdot G_{air} \cdot \left(t_{air} - t_{out}\right)/3600 \text{ [kW]} \quad (7)$$

where:

Q - the estimated amount of heat saved by sending warm air from indoor structure into production areas [kW],

ρ - air density [kg/m^3],

G - air exchange calculated by the method described in [4] [kg/hour],

t - temperature of inlet and ambient air [°C].

In the case of the indoor structure blocking, the livestock building heat loss at air exchange will be minimal. Let us consider the case of combining a greenhouse and a barn for 100 cow heads, which was built in the Poltava region. According to the calculation of air balance between these buildings, we determine energy savings for heating barns in winter at different values of the outdoor temperature (Tab. 1).

The calculation of seasonal heating energy savings for such a complex, according to the meteorological data of the Poltava region in 2013 amounted to 60,806 kW. In terms of standard fuel, the saving makes 1.8 tons or 1306 kg of natural gas per year. Thus, the sources of efficient industrial waste use at combining buildings and structures are: cost savings in feeding plants with carbon dioxide, cost savings for heating and humidification.

The problems of blocked buildings are not less topical both, at reconstruction and expansion of existing farms, and at construction of new livestock farms buildings.

CONCLUSIONS

Search of the best dimensions of buildings and structures at combining them for air exchange is based on using waste and reducing the consumption. The efficiency is achieved through cost savings in feeding plants with carbon dioxide, cost savings in heating and humidification.

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SPOSOBY OSZCZĘDZANIA ENERGII PRZY POŁĄCZENIU BUDYNKÓW I OBIEKTÓW ROLNICZYCH

Problem oszczędzania energii i efektywnego wykorzystania zasobów ma zasadnicze znaczenie dla rolnictwa Ukrainy. Artykuł poświęcony został analizie sposobów oszczędzania energii, racjonalnego i ponownego wykorzystania zasobów w gospodarstwach rolnych poprzez połączenie różnych budynków i obiektów produkcyjnych. Dzięki wykorzystaniu wspólnej wymiany powietrza między pomieszczeniami produkcyjnymi o różnym przeznaczeniu występuje możliwość wykorzystania ciepła odpadowego, które w normalnych warunkach jest usuwane na zewnątrz obiektów. W powietrzu budynku przeznaczonego na produkcję hodowlaną występuje również znaczna koncentracja dwutlenku węgla i nadmiar wilgoci, które można skierować do urządzenia zasilającego rośliny i nawilżania powietrza zgodnie z odpowiednimi zasadami uprawy roślin. Dla oszczędności wydatków na ogrzewanie budynku inwentarskiego wskazane jest wykorzystanie ciepła z powietrza, z obiektów szklarniowych. Przeprowadzone w artykule badania wykazały, że w celu zmniejszenia zużycia energii i wykorzystania ciepła odpadowego z produkcji w gospodarstwach rolnych racjonalne jest łączenie odpowiednich budynków i obiektów ze sobą.

Słowa kluczowe: **budynek, szklarnie i tunele pod uprawy, energoefektywność, odpady**